AIR CAR BASICS

—or—

Why I decided to devote my life to photocopying everything ever published on compressed air cars.

by Scott Robertson

1981

Published by Pneumatic Options Research Library,
2004, because *it's still true!*

www.AirCarAccess.com

Introduction

This book is meant to serve as a companion to "Air Powered Cars," a 48-page book by Terry Miller, the inventor (1979) of the first compressed-air car that's competitive in range and speed with electric cars. Terry Miller's book goes into detail on air car hardware and building procedure; I've covered the engineering principles and formulas you'll need to understand air car specifications and requirements, and I've compared nine different types of automotive power according to 24 criteria. The air car rated the best; if it hadn't, I wouldn't have written this book.

You'll need Terry Miller's book to learn enough about the specific components of an air car to make one. Copies can be ordered from Terry Miller, PO Box 80, Crestline, Kansas, 66728; 316/389-2299. (OBSOLETE--Terry Miller is deceased.)

Copies of "Air Car Basics" can be ordered for $3 apiece, or half price for orders of a dozen or more, from Donald Scott Robertson, 12001 Highway 20, Grass Valley, California, 95945; 916/273-3559. (OBSOLETE--see below.)

I'd like to hear from anyone who's interested in air cars. I urge all air car enthusiasts to cooperate and communicate with each other in order to speed the birth of the air car industry.

Editor's note, 2004: This booklet was my first essay on air cars, just 2 years into a research project that is now a quarter-of-a-century old. The information it contains is still valid, but copies are now $10 and can be ordered at: http://www.aircaraccess.com.

Chapter One: Comparing the Alternatives

The largest proportion of research and development of alternative cars has centered around electric cars. But don't assume that electric cars are the main target of attention rather than some other alternative, for practical reasons. The real reason for electric cars getting all the attention is lack of information, which, combined with lack of imagination, has led experimenters to plunge into electric car development without giving equal thought to all the alternatives.

This happens because everyone knows about electricity: that it powers electric motors like gasoline powers gas engines, and that its stored in batteries like gasoline is stored in gas tanks. But how many people know that compressed air can be used in the same ways? Not many, due to our relative lack of exposure to compressed air systems. There are many more people who think of electricity and gasoline as power sources than there are who think of compressed air as a power source. When we want to use blenders, mow lawns, heat water, watch T.V. or rototill gardens, we automatically turn to electricity or gas. But our reasons for choosing a particular power source aren't objectively based on comparing the advantages of the available alternatives; we just do things the way we're used to doing them, until we're forced by insurmountable crisis to do things a new way.

Inventors who have considered air cars have also missed the boat because of lack of information and imagination. Compressed air is used to power types of motors similar to the various types of gasoline motors--piston, turbine, rotary--and inventors have limited their imaginations by overequating compressed air with gasoline. The new invention that has finally made compressed air a feasible source for automotive power was thought of as a result of someone first considering a quality that compressed air has and that gasoline lacks, and then using that quality to invent a uniquely efficient air motor.

This unique quality of compressed air is that after it's been used to power one piston, it's still potent enough to power up to five more pistons. Gasoline, on the other hand, is mostly burned up after powering one piston. It's possible to get a little more power from gasoline exhaust by burning it in a secondary engine, but that's not the point. The point is that air car inventors of the past have failed to recognize and use the uniqueness of compressed air as a power source. So until 1979, you couldn't get a practical driving range between fill-ups with a feasible amount of stored air. Terry Miller's invention has made it possible to use the same air up to six times. He never would've thought of this if he'd limited his imagination by overequating compressed air with gasoline.

Why did it take this long for someone to think of such a simple thing? Because it's only been a few years since a noticeable proportion of consumers has been forced to feel a noticeable desire to give up doing things the old way in order to not have to buy gasoline. When gas was cheap, few people wanted to invest in developing alternative cars that probably wouldn't have all the conveniences of gas cars anyway.

But in the '70's, our global distraction became a supposedly temporary economic crisis accompanying a so-called gas crisis. The price of gas has been rising, seemingly out of our control, ever since, and has been a pretty good mirror of what other sectors of the economy are going through. Finally, everything got so bad, as mirrored and/or caused by the price of oil, that the likelihood began swiftly increasing that someone would be moved to think of the most feasible solution according to the most realistic criteria.

I've compared the advantages of the nine most feasible types of auto power, according to 24 criteria, and air powered cars are the most feasible. Electric cars are the most popular, but their advantages rate poorly compared with the other alternatives.

AIR CARS VERSUS ELECTRIC CARS

The weight, initial cost, and short life of batteries make driving electric cars more expensive overall than driving gas cars at 1978 prices (62-67¢/gallon). With technology existing today,fuelling an air car can be much faster and cheaper than recharging an equivalent electric car, especially considering that batteries wear out; they must be maintenanced regularly and periodically replaced, unlike compressed air storage tanks (also called receivers, air cylinders, air bottles). Air motors are simpler and cheaper to rebuild than equivalent electric motors, last longer and are more efficient.

Electric and air cars have similar ranges now and similar potential ranges for the future. But the set-up needed to refuel an air car in a few minutes is much simpler, thus less expensive, than that needed to get an equivalent charging time for an equivalent electric car. Both electric and air cars have sufficient ranges as town cars, but air cars, with a refuelling time of less than five minutes, can be driven all day.

Air stations will have to be all over the place like gas stations are now, but will be much cheaper to own and operate since the fuel is free and the only costs are the purchase and maintenance of the equipment. Air stations can be cooperatively financed, non-profit and left unmanned. It's not technologically or economically feasible to transmit air from a central compressed air plant the way electricity is transmitted from central power plants. This will make it hard for air car fuelling to be in the hands of centralized monopolies the way electric utility companies are, if air stations generate their own compressed air and/or electricity.

Most energy for recharging electric cars would come from coal and nuclear power plants. Using coal pollutes the air; coal is a non-renewable fuel; coal mines are dangerous, unhealthy places to work. Nuclear breeder reactors are fuelled by man-made plutonium, the most potent and long-lived poison ever introduced onto this planet. Converting to 100% electric cars would cut urban emissions of hydrocarbons and carbon monoxide by about half, but raise emissions of sulphur oxides about 20% due to the generation of more electricity. Sulphur oxides are a worse kind of pollution than gas car exhaust. It will be important to install windmills, water wheels and solar panels at air stations to avoid the high cost of electricity, both in dollars and pollution. Air stations can be set up in stages, using electricity from the power company to power the compressor when the air station is first set up, making possible a faster transition to air cars than if windmills had to be set up simultaneously with the first use of the compressor.

Converting to 100% electric cars would be difficult with the main battery materials now being used or considered (lead-acid, nickel-zinc and lithium-sulphur). Identified reserves of batteries are no more abundant than those of petroleum for meeting world demand through the year 2000, but all materials used to build air storage tanks are abundant and recyclable.

Use of gas cars inevitably leads to oil spills, big and small, on land and sea; use of electric cars leads to the problem of what to do with dead batteries: boxes full of sulphuric acid and lead. Some local dumps recognize this danger to the extent that they have special provisions for accepting dead batteries.

Aside from extra costs to motorists, conversion to electric cars would have little economic impact in the U.S. But conversion to air cars would eliminate one-fourth of our total petroleum use, could make travelling cheaper than most of us have yet experienced it, would decentralize the auto industry, would help hold back an oil war, and would demonstrate to us that we do have freedom of choice.

OTHER ALTERNATIVES

The nine types of automotive power that I've compared are: gasoline internal combustion, diesel, electric, hybrid gasoline/electric, gas turbine, steam, hydrogen internal combustion, Stirling (external combustion and heat exchange), and compressed air.

The 24 criteria I used are:

A. Technology needed for production exists today
  1. technology for generating this type of power
  2. technology for producing motor
  3. technology for producing energy-storage components

B. Cost
  4. initial cost to buy car
  5. cost of maintenance
  6. cost of fuel
  7. life of motor components
  8. life of energy-storage components
  9. cost to rebuild
  10. weight
  11. simplicity

C. Advantage to the economy
  12. lessens dependency on fossil fuels, nuclear power and monopolies

D. Convenience
  13. distance car can go between fuelling (range)
  14. cruising speed
  15. acceleration
  16. technology needed for quick fill-up
  17. technology needed for little or no warm-up time

E. Pollution
  18. air pollution

  19. noise pollution

F. Safety

  20. of motor components
  21. of energy-storage components

G. fuel accessibility

  22. simplicity of processing from raw materials
  23. lending itself to exploitation by monopolies
  24. renewability of raw materials for fuel

I've scored each of the nine alternatives according to each of the 24 criteria with this code:

0: definitely prohibitive disadvantage
1: some obvious disadvantage
2: advantage of questionable signifigance
3: advantage of average significance
4: advantage of relatively outstanding significance

My results, tabulated in Chart One, show that air cars are the most feasible alternative, and that until all electricity is generated by appropriate technology such as solar, wind and water power, electric cars are no more advantageous overall than cars directly using fossil fuels.

Comparing the relative advantages of the types of auto power with their relative popularity shows the

Chart One: Relative Advantages of the Most Feasible Alternatives

Rating Code:

0: definitely prohibitive disadvantage; 1: some obvious disadvantage; 2: advantage of questionable significance; 3: advantage of average significance; 4: advantage of relatively outstanding significance. NOTE: I've done this chart objectively using the best information I can find. I invite expert criticism.

	gasoline int. comb.	diesel	electric	hybrid electric/gas	gas turbine	steam	hydrogen int. comb.	compressed air	Stirling heat exchange
A. Existing technology to make:									
1. fuel	4	4	4	4	4	4	1	3	4
2. motor	4	3	4	4	2	1	3	3	0
3. storage components	4	4	2	3	4	4	2	3	4
B. Cost									
4. initial cost	3	3	2	4	2	1	1	3	1
5. maintenance cost	2	3	2	3	4	3	2	4	3
6. fuel cost	0	1	1	2	1	1	1	3	2
7. life of motor	3	3	4	3	4	3	3	4	3
8. life of storage components	4	4	1	2	4	4	3	4	4
9. rebuilding cost	3	3	3	3	2	2	3	4	2
10. weight	3	3	2	3	3	2	3	1	3
11. simplicity	2	3	3	3	3	2	3	4	2
C. Advantage to economy									
12. reduce energy dependency	0	0	2	1	2	1	4	3	2
D. Convenience									
13. range	4	4	3	4	3	3	3	2	3
14. speed	4	4	3	4	4	4	3	3	3
15. acceleration	4	4	2	4	3	4	3	2	3
16. quick fill-up	4	4	0	4	4	4	4	4	4
17. no warm-up time	2	2	4	3	4	3	3	4	3
E. Pollution									
18. air pollution	0	0	2	2	1	3	3	4	2
19. noise pollution	1	1	4	3	2	3	2	4	4
F. Safety									
20. motor	1	1	2	2	2	2	2	3	2
21. storage components	2	2	2	2	2	2	2	2	2
G. Fuel accessibility									
22. processing simplicity	1	2	2	2	2	2	2	4	2
23. not monopolized	0	0	2	1	2	1	2	3	2
24. renewability	0	0	3	1	0	0	4	4	0
TOTALS	54	58	59	67	64	59	62	78	60

fittingness of my assertion that the degree of popularity of a type of auto power hasn't been proportional to how advantageous it was. Electric and gas cars are the most popular and least advantageous.

Below are a few details about some of the alternatives. I don't intend to explain in detail the workings and advantages of all the different types of auto power. For further reading about such things, refer to the bibliography at the back of this book.

Gasoline Internal Combustion

The fact that the technology exists to build gas cars is a curse in disguise. The size and power of the automobile and petroleum industries provide jobs for many people, fortunes for a few, and a ruined social/economic/physical environment for all of us.

Gas cars are designed to contain and use the energy of burning gasoline. With existing technology, gas cars go faster and farther than any other, since so much energy is contained in so little gasoline by weight. This means convenience for the consumer, bad air, mobility for an arm and a leg, and the enslavement of hundreds of millions of people to their own addiction to comfort. A car that only goes 20 mph up a hill still gets you up the hill, but a gas car without gas does nothing. No one will be sorry to have a less convenient car to drive when gas cars become useless (before 1990), but no one will have a car at all if we don't start manufacturing, popularizing and developing the best alternative now.

Steam Cars

The main advantage of steam cars is that they are external combustion engines. The fuel isn't burned at high pressures and varying speeds to the extent that it is in internal combustion engines. External combustion burns fuel more completely and in a more controlled way, thus pollutes very little. Fuel cost is the problem. It costs more to drive a steam car than an air car because of the cost of combustion fuel.

Hydrogen Internal Combustion

The raw material used to produce hydrogen is water. The exhaust from a hydrogen car is also water. Minor modifications to existing gas engines make them able to be powered by hydrogen. But the technology for producing and storing hydrogen safely doesn't exist on anything resembling a large enough scale to make conversion to hydrogen cars feasible in the near future. The complexity of setting up a large-scale hydrogen production and storage industry would lend itself perfectly to control by monopolies.

Stirling Heat Exchange Engines

A relatively good alternative, but production would require the tooling-up of an entire industry from the ground up.

Compressed Air

Pneumatic equipment (equipment powered by compressed air) has been produced for over a hundred years and is being manufactured by hundreds of separate competitors. Since pneumatic equipment has been geared mostly to industry rather than consumers on a household level, safety standards within the industry are very high.

Locomotives driven by compressed air were being used in mines over a hundred years ago. That was before radio, T.V., telephone or humans on the moon.

Because of the simplicity of pneumatic equipment, compared to any motive-power source that must contain and use heat, combustion or electricity, and because of the established and competitive state of the compressed air industry, the cost to fuel, maintain and rebuild air cars is less than any other alternative.

Even with the limited range per fill-up (45 miles) that Terry Miller says we can get from today's prototype air cars, their convenience factor is still competitive with gas cars and superior to electric cars, since an air car can be refuelled in a few minutes. If we become dependent on electricity for our mobility, the utility monopolies will show us little more charity than the oil-producing nations are showing us now.

Air motors are one of the quiet-running alternatives as opposed to internal combustion engines. The only noise produced by an air car is the hiss of the exhaust air, which is quieted by simple mufflers, standard equipment for pneumatic devices.

With the condition that compressors aren't powered by electricity produced by polluting generating plants, the air car is 100% non-polluting and more: compressors clean the air before compressing it. Air filters are essential equipment on pneumatic systems; some foreign particles, such as oil, can cause explosions if not removed from the air before it's compressed. So pneumatic devices generally exhaust air that's cleaner than the surrounding atmosphere.

A faulty air tank, hose or piston can also explode; this won't happen unless the equipment isn't properly tested at the factory. I already mentioned the high safety standards of the industry. Good equipment can explode under these conditions: 1) if too much pressure is used, which will only happen if you ignore safety precautions or if safety devices malfunction; 2) if a collision ruptures an air tank.

Pressure explosions don't involve fire; the danger is from pieces of flying metal. Only explosions caused by compression of foreign matter in the air involve fire. This kind of explosion is the most dangerous, demonstrating the importance of proper installation and maintenance of air filters. Prevent injury from any potential explosion by installing a shield of strong, lightweight material such as bulletproof plastic between the storage tanks and the passengers. If you follow the safety precautions spelled out in Terry Miller's book, your air car will be much safer than most of the gas cars you've ridden in.

One of the more widespread applications of pneumatics in the past 100 years has been the use of air motors in mines. Explosive gasses are commonly found in mines, making it dangerous to use any sparking motor such as electric or internal combustion. Other reasons for using air motors in mines: they aren't damaged by overloading, and are lighter than gas or electric motors.

Converting raw material (atmosphere) into air car fuel (compressed air) requires less energy than does the processing of most other fuels, especially combustion fuel. Air compressors last for 20 years.

In the category "doesn't lend itself to exploitation by monopolies," air cars again lead. Closely tied to its other advantages, the air car has more access to its fuel than other cars have to their fuels because it's harder for would-be energy monopolizers to monopolize the wind, which is everywhere, than it has been for them to monopolize earthbound deposits of petroleum, natural gas and coal.

No potential car fuel is more renewable than air. The term "renewable" doesn't even apply, since the air is used without being used up. The pressure is used up, but the air isn't. After being used, it's exhausted back into the atmosphere in a chemically unchanged state, except that it's cleaner than before it was compressed. If we ever run out of air to breathe, it won't be because of air cars.

Half of the energy we use in the U.S. is accounted for by petroleum use. Half of our petroleum use is accounted for by transportation energy use. Half of our transportation energy use is accounted for by passenger car use. Thus, passenger car use accounts for one eighth of our total energy use and one-fourth of our total petroleum use.

In the slicing of the U.S. energy-use pie, no sector gets a bigger piece than passenger car use.

It's time to decide: do we, or don't we want to deliver the single most disintegrating blow we can to the stranglehold that our petroleum habit has on our moneyspending (energy-spending) habits? If the gas car were completely eliminated, a full one-fourth of our present petroleum use would be eliminated. That's half the oil we import.

How can the gas car be eliminated when it seems to be Human's Best Friend?

The crisis that has made it hard for us to get around has also created the demand for the alternative car that will make it easier for us to be mobile again, and that will give us some assurance that we won't be buying our mobility from monopolies.